(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 669 110 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
03.05.2000 Bulletin 2000/18

(51) Int Cl.[7]: **A61B 17/86**

(21) Application number: **95300882.8**

(22) Date of filing: **13.02.1995**

(54) **Interference screw having a double tapered root**

Interferenzschraube mit doppelt konischem Kern

Vis d'interférence avec âme conique double

(84) Designated Contracting States:
AT BE CH DE DK ES FR GB GR IE IT LI LU MC NL PT SE

(30) Priority: **14.02.1994 US 196720**

(43) Date of publication of application:
30.08.1995 Bulletin 1995/35

(73) Proprietor: **SMITH & NEPHEW, INC.**
Memphis, Tennessee 38116 (US)

(72) Inventor: **Huebner, Randall J.**
Aloha, Oregon 97007 (US)

(74) Representative: **Gilholm, Stephen Philip et al**
Corporate Patents Department
Smith & Nephew Group Research Centre
York Science Park
Heslington York YO1 5DF (GB)

(56) References cited:
FR-A- 2 642 958
FR-A- 2 704 140
US-A- 5 211 647
US-A- 5 234 430

EP 0 669 110 B1

Printed by Jouve, 75001 PARIS (FR)

Description

[0001] This invention relates generally to apparatus for securing bone and ligament grafts to a bone mass and more particularly to an orthopedic fixation screw for holding the graft inside a bore.

[0002] The anterior cruciate ligament (ACL) is frequently injured in contact sports and other activities. Such injuries cause instability in the knee to an extent that ACL reconstruction may be required.

[0003] In ACL reconstruction, a substitute ligament or graft is attached to the distal femur or proximal tibia to facilitate regrowth and permanent attachment. Various methods of graft attachment are known, such as staples and sutures, however, such attachment methods are often not strong enough to withstand normal stress placed on the ligament.

[0004] One method for increasing the strength of the graft attachment comprises wedging an interference screw between a graft bone block and an interior wall of a bore formed though the bone mass. Although interference screws are stronger than other ligament attachment methods, such as staples, the sharp outer edges of the screw often cut or fray the ligament after the screw is fixated inside the bore.

[0005] U.S. Pat. No. 5,211,647 to Schmieding describes a sheath used for protecting a ligament graft during the insertion process of an interference screw. The sheath contains a cutout portion that enables the interference screw to be exposed to the tunnel wall of the bone during insertion, while at the same time covering the side of the screw facing the graft. The interference screw contains a rounded back section to further reduce the effects of graft cutting.

[0006] Because there are no threads at the back end, the screw shown in Schmieding has reduced purchase over fully threaded screws of comparable size. Reduced purchase in the screw increases the chance that the ligament graft may slip in the bore.

[0007] Further, the screw in Schmieding has a cylindrical root portion that provides only nominal compression of the graft against the inside wall of the bore.

[0008] A constant root diameter also exhibits substantially constant resistance when inserted by a surgeon into the bore. Thus, it is hard for the surgeon to physically gauge exactly how far the interference screw has been inserted into the bore. For example, it is important that the screw is not inserted too far past the back end of the bore, while at the same time important that the screw does not extend partially out of the bore after completion of the installation process. The screw in Schmieding, however, gives no physical indication that insertion is near completion.

[0009] In US 5,234,430, an orthopaedic fication screw is disclosed comprising all the features of the pre-characterising part of claim 1.

[0010] In FR 2 642 958, a screw for the treatment of fractures of the vertebral column is disclosed. The screw comprises a core with a variable diameter, the section with the smallest diameter being located at the tip while the section with the widest diameter is located at the head.

[0011] Accordingly, a need remains for a high purchase interference screw that will not cut or fray an attached ligament graft.

[0012] It is, therefore, an object of the invention to increase the purchase of interference screws.

[0013] Another object of the invention is to reduce fraying or cutting effects caused by interference screws on bone and ligament grafts.

[0014] A further object of the invention is increase the strength in which grafts can be attached to a bone mass.

[0015] In accordance with the present invention, we provide an orthopaedic interference screw for compression anchoring a bone graft in a bore formed in the bone mass, said screw comprising:

a root having front and back ends and further including a center section, a back section, a screw thread formed over substantially all of the centre and back sections and a taper formed on said root back section and extending substantially entirely between said back end and said center section, characterised in that said taper is larger toward the back end than toward the center section and the screw thread includes a crest with an outer surface having a width that increases at least along the back section away from the center section.

[0016] An orthopedic fixation screw contains a specially shaped root portion that anchors bone grafts more securely inside bores in a bone mass. The screw is less likely to cut a ligament graft and also provides a positive positional indication to a surgeon when inserting the screw inside the bore.

[0017] The screw includes a root portion having a front and back end. The root portion includes a front section, a cylindrical center section and a back section. A screw thread is formed over substantially the entire root portion for increased purchase capacity.

[0018] Preferably the root back section includes an outer surface, the back end outer surface having a rounded edge between said back end outer surface and the outer surface of the root back section.

[0019] Preferably the root diameter is substantially constant along the center section, thereby maintaining a substantially uniform diameter across the thread along the center section of the root.

[0020] Preferably the distance between the screw thread crest and the outer surface of the root along substantially the entire back section diminishes toward the back end.

[0021] The distance between the thread crests and the outer surface of the root along the back root section may diminish inversely to said taper, thereby maintaining a substantially uniform diameter across the thread along the back section of the root.

[0022] The root may further include a front section having a taper, said front section taper extending sub-

stantially entirely along the front section, such that the front section root diameter decreases away from the center section.

[0023] The screw thread crest may extend above the outer surface of the root, the distance between the screw thread crest and the outer surface of the root along the center section is substantially constant along the center section, thereby maintaining a substantially uniform diameter across the thread along the center section of the root.

[0024] A taper is formed on the back section to increase compression against the graft. The screw further includes a rounded portion formed between the taper and the back end of the root that prevents the ligament from being cut or frayed after the screw is fully inserted.

[0025] The thread maintains a uniform crest diameter along the back and middle sections. The crest of the thread also has a top face that increases in width toward the back end of the root portion. The root portion can either be cannulated for receiving insertion guide wires or can have a solid center with a rounded front end.

[0026] The foregoing and other objects, features and advantages of the invention will become more readily apparent from the following detailed description of a preferred embodiment of the invention which proceeds with reference to the accompanying drawings.

[0027] FIG. 1 is a side section view of a fixation screw according to the invention.

[0028] FIG. 2 is a rear view of the fixation screw shown in FIG. 1.

[0029] FIG. 3 is a side section view of the fixation screw shown in FIG. 1 partially inserted into a bore between an interior wall of a bone mass and a ligament graft.

[0030] FIG. 4 is the side section view of FIG. 3 with the fixation screw fully inserted into the bore.

[0031] FIG. 5 is an alternative embodiment of the fixation screw according to the invention having a solid root portion.

[0032] FIG. 6 is a rear view of the fixation screw shown in FIG. 5.

[0033] FIG. 1 is a side section view of an orthopedic fixation screw 12 according to the invention. The fixation screw 12 has a elongated root portion 14 with a circular cross sectional shape. The root portion 14 includes a front end 26 and a back end 28 and is generally defined by a front section 16, a center section 18 and a back section 20. A thread 22 is formed over substantially the entire root portion 14 from the front end 26 to the back end 28.

[0034] A taper 24 is formed on the back section 20 between the back end 28 and the center section 18. The taper 24 includes an outside surface 25 that extends laterally out from the root portion 14 at an angle 30. The angle 30 of outside face 25 makes the taper larger toward the back end 28 than toward the center section 18. In one embodiment, the outside surface 25 of taper 24 has an slope of approximately 7 degrees in relation to an outside surface 36 of root 14. A rounded portion 32 is formed between the taper 24 and the back end 28 of root 14.

[0035] The center section 18 has a cylindrically shape. The front section 16 is tapered from the front end 26 to the center section 18 and has a larger diameter toward the center section 18 than toward the front end 26. The front, center and back sections of the root portion 14 each have substantially the same length.

[0036] The thread 22 includes a crest 38 that extends a given height above the outside surface 36 of root 14. The crest height diminishes between the center section 18 and the back end 28 inversely to the slope 30 of taper 24. Thus, a substantially uniform crest diameter 40 is maintained along the back section 20 and middle section 18. The crest diameter 40 narrows slightly along the front of the screw in proportion to the taper on front section 16. The crest 38 includes a top face 39 that increases in width toward the back end of the root as is shown in FIG. 3.

[0037] In one embodiment, the root portion 14 is cannulated for receiving guides wires that direct the screw to a desired mounting position. Referring both to FIG. 1 and to the back view of the fixation screw 12 shown in FIG. 2, the cannulated root portion 14 includes a hexagonal socket 42 for engaging a screw driver (not shown). A center channel section 46 and a front channel section 48 each have circular cross sectional shapes that combine to extend through the center section 18 and front section 16, respectively.

[0038] FIG. 3 is a side section view of the fixation screw 12 in FIG. 1 shown partially inserted into a bore 54. In the case of ACL reconstructive surgery, the bore is formed in the distal femur or proximal tibia, or both. Screw 12 is used to anchor a bone-tendon graft 56 inside bore 54 which is also referred to as an endosteal tunnel. Graft 56 includes a tendon 60 and a bone portion 62.

[0039] An orthopedic surgeon drills into bone mass 52 using a convention orthopedic drill and which may be done endoscopically. After bore 54 is drilled as shown in FIG.3, one end of graft 56 is positioned in the bore as illustrated. Screw 12 is fitted onto a driver (not show) by inserting a hexagonal front end of the driver into socket 42 (FIG. 1). The surgeon grasps the driver and positions the front end 26 of screw 12 between an interior wall 58 of bone mass 52 and tendon 60.

[0040] The surgeon pushes the driver axially toward screw 12 while at the same rotating the driver. The threads 22 in turn engage both the inner wall 58 and ligament 60. As the front end of screw 12 advances further into the space between ligament 60 and wall 58, the tapered front section 16 (FIG. 1) gradually compresses graft 56 and bone portion 62 against the opposite side of bore 54. Compression against graft 56 is steadily increased as screw 12 is inserted further into bore 54. The screw 12 is inserted until the back section 20 (FIG. 1) reaches the front of bore 54 as shown in FIG.

3.

[0041] Referring to FIG. 4, as the tapered back section 20 begins insertion into bore 54, the rate in which the screw 12 compresses against graft 56 increases. More force is thereby required by the surgeon to further insert the remaining portion of screw 12 into bore 54. The added resistance from screw 12 gives the surgeon positive feedback as to how far the screw is presently inserted into bore 54. The taper 24 on the back portion of root 14 also increases purchase over standard cylindrical roots. Thus, screw 12 holds graft 56 more securely inside bore 54 than other screws of comparable size.

[0042] The top face 39 increases in width toward the back of screw 12. Each turn of crest 38 thereby cuts a wider groove into wall 58 than the proceeding turn. The threads in the back of screw 12 will then not sit loosely in grooves previously bored by proceeding threads. Thus, each thread is held firmly in bone mass 52 further reducing the possibility of screw 12 coming loose.

[0043] The tapered front root section 16 allow the threads 22 to gain purchase at a relatively narrow portion of the root in turn reducing shifting or twisting of graft 56 during installation. Therefore, it is not necessary to provide a cannulated root portion 22 and guide wires that would normally be used to prevent screw divergence during installation.

[0044] Screw 12 is further inserted until the back end 28 is fully seated inside bore 54 as illustrated in FIG. 4. The rounded portion 32 of screw 12 prevents cutting or fraying of ligament 60 when ligament 60 is flexed during regular leg movements. Once the screw 12 is positioned as shown in FIG. 4, the surgeon withdraws the driver from socket 42.

[0045] FIG. 5 shows a screw 64 having a solid root portion 70. FIG. 6 is a back view of the fixation screw 64 showing a hexagonal socket 68 for receiving a driver (not shown). Screw 64 includes the same tapers in the front and back sections of the root portion 70. A rounded portion 66 is located at a front end 65.

[0046] Having described and illustrated the principles of the invention in a preferred embodiment thereof, it should be apparent that the invention can be modified in arrangement and detail without departing from such principles. I claim all modifications and variation coming within the scope of the following claims.

Claims

1. An orthopaedic interference screw (12) for compression anchoring a bone graft in a bore formed in the bone mass, said screw (12) comprising:

   a root (14) having front (26) and back ends (28) and further including a center section (18), a back section (20), a screw thread formed over substantially all of the centre (18) and back (20) sections and a taper (24) formed on said root back section (20) and extending substantially entirely between said back end (28) and said center section (18), characterised in that said taper (24) is larger toward the back end (28) than toward the center section (18) and the screw thread (22) includes a crest (38) with an outer surface (36) having a width that increases at least along the back section (20) away from the center section (18).

2. A screw (12) according to claim 1 wherein said screw further includes a rounded portion (32) formed between said taper (24) and said back end (28).

3. A screw (12) according to claim 1 wherein the distance between the thread crests (38) and the root (14) along the center section (18) is substantially constant.

4. A screw (12) according to claim 3 wherein the distance between the thread crests (38) and the root portion (14) in the back section diminishes between the center section of the root portion (14) and the back end (28).

5. A screw (12) according to claim 4 wherein the crest height over the back root section (20) diminishes inversely to said taper (24) thereby maintaining a substantially uniform crest diameter along the back (20) and middle sections (18) of the root portion.

6. A screw (12) according to claim 2 wherein said root portion(14) further includes a front section (16) having a taper formed thereon, said front section taper extending substantially entirely between said front end (26) and said center section (18) and being larger toward the center section (18) than toward the front end (26).

7. A screw (12) according to claim 1 wherein the crest (38) of the screw thread includes a top face (39) having a width that increases toward the back end of the root (14).

8. A screw according to claim 1 wherein the root portion (14) is cannulated.

9. A screw according to any one of claims 6 to 8 wherein the front and back sections (20) are substantially the same length.

10. A screw (12) according to claim 1 wherein the taper (14) has a slope of approximately 7 degrees.

11. A screw (12) according to claim 1 including a channel extending longitudinally through the root from the front end to the back end, the channel having a hexagonal socket in the back section for engaging a driver and a circular cross-sectional shape-in the

center and front sections.

12. A screw (12) according to claim 1 including a rounded nose section joined to the front end of the root.

Patentansprüche

1. Orthopädische Interferenz-Schraube (12) für die Druckverankerung eines Knochen-Transplantats in einer Bohrung, die in einer Knochenmasse hergestellt ist, wobei diese Schraube (12) umfaßt:
einen Kern (14) mit stirnseitigem (26) und rückseitigem (28) Ende und ferner mit einem Mittelabschnitt (18), einem rückseitigen Abschnitt (20), einem Schraubengewinde, welches über im wesentlichen der Gesamtheit des Mittelabschnittes (18) und des rückseitigen Abschnittes (20) ausgebildet ist, und einem Konus (24), welcher an dem rückseitigen Abschnitt (20) des Kerns ausgebildet ist und sich im wesentlichen ganz zwischen dem rückseitigen Ende (28) und dem Mittelabschnitt (18) erstreckt, **dadurch gekennzeichnet**, daß der Konus (24) in Richtung auf das rückseitige Ende (28) größer wird als in Richtung auf den Mittelabschnitt (18) und das Schraubengewinde (22) einen Scheitel (38) mit einer äußeren Fläche (36) aufweist, deren Breite wenigstens entlang dem rückseitigen Abschnitt (20) weg vom Mittelabschnitt (18) zunimmt.

2. Schraube (12) nach Anspruch 1, die weiter einen abgerundeten Bereich (32) aufweist, der zwischen dem Konus (24) und dem rückseitigen Ende (28) ausgebildet ist.

3. Schraube (12) nach Anspruch 1, bei welcher die Entfernung zwischen den Gewindescheiteln (38) und dem Kern (14) entlang dem Mittelabschnitt (18) im wesentlichen konstant ist.

4. Schraube (12) nach Anspruch 3, bei welcher die Entfernung zwischen den Gewinde-Scheiteln (38) und dem Kernbereich (14) am rückseitigen Abschnitt zwischen dem Mittelabschnitt des Kernbereiches (14) und dem rückseitigen Ende (28) abnimmt.

5. Schraube (12) nach Anspruch 4, bei welcher die Scheitelhöhe über dem rückseitigen Kernabschnitt (20) entgegensetzt zum Konus (24) abnimmt, wodurch ein im wesentlichen einheitlicher Scheitel-Durchmesser entlang dem rückseitigen Abschnitt (20) und dem Mittelabschnitt (18) des Kernbereiches aufrechterhalten wird.

6. Schraube (12) nach Anspruch 2, bei welcher der Kernbereich (14) weiterhin einen stirnseitigen Abschnitt (16) aufweist, an welchem ein Konus angeformt ist, und der Konus des Frontabschnittes sich im wesentlichen ganz zwischen dem stirnseitigen Ende (26) und dem Mittelabschnitt (18) erstreckt und in Richtung auf den Mittelabschnitt (18) größer wird als in Richtung auf das stirnseitige Ende (26).

7. Schraube (12) nach Anspruch 1, bei welcher der Scheitel (38) des Schraubengewindes eine oberseitige Fläche (39) aufweist, deren Breite in Richtung auf das rückseitige Ende des Kerns (14) zunimmt.

8. Schraube nach Anspruch 1, bei welcher der Kernbereich (14) als Kanüle ausgebildet ist.

9. Schraube nach einem der Ansprüche 6 - 8, bei welcher der stirnseitige Abschnitt und der rückseitige Abschnitt (20) im wesntlichen gleich lang sind.

10. Schraube (12) nach Anspruch 1, bei welcher der Konus (14) eine Neigung von etwa 7° aufweist.

11. Schraube (12) nach Anspruch 1, mit einem Kanal, der sich in Längsrichtung durch den Kern vom stirnseitigen Ende zum rückseitigen Ende erstreckt und im rückseitigen Abschnitt eine sechseckige Fassung aufweist, die mit einem Schraubendreher in Eingriff bringbar ist, und im Mittelabschnitt und im stirnseitigen Abschnitt eine kreisförmige Querschnittsform aufweist.

12. Schraube (12) nach Anspruch 1, die mit einem abgerundeten Ansatzabschnitt versehen ist, der mit dem stirnseitigen Ende des Kernes verbunden ist.

Revendications

1. Vis orthopédique à interférence (12) pour ancrage en compression d'une greffe osseuse dans un trou formé dans la masse de l'os, ladite vis (12) comprenant :
une racine (14) ayant des extrémités avant (26) et arrière (28) et incluant en outre une partie centrale (18), une partie arrière (20), un filetage formé sensiblement sur la totalité des parties centrale (18) et arrière (20), et une région conique (24) formée sur ladite partie arrière (20) de la racine et s'étendant sensiblement entièrement entre ladite extrémité arrière (28) et ladite partie centrale (18), caractérisée en ce que ladite région conique (24) est plus grosse vers l'extrémité arrière (28) que vers la partie centrale (18) et le filetage (22) possède une crête (38) avec une surface extérieure (36) ayant une largeur qui augmente au moins le long de la partie arrière (20) en s'éloignant de la partie centrale (18).

2. Vis (12) selon la revendication 1, dans laquelle ladite vis comprend en outre une portion arrondie (32) formée entre ladite région conique (24) et ladite extrémité arrière (28).

3. Vis (12) selon la revendication 1, dans laquelle la distance entre les crêtes (38) du filetage et la racine (14) le long de la partie centrale (18) est sensiblement constante.

4. Vis (12) selon la revendication 3, dans laquelle la distance entre les crêtes (38) du filetage et la racine (14) dans la partie arrière diminue entre la partie centrale de la racine (14) et l'extrémité arrière (28).

5. Vis (12) selon la revendication 4, dans laquelle la hauteur de la crête au-dessus de la partie arrière (20) de la racine diminue en sens inverse de ladite région conique (24), ce qui maintient un diamètre de crête sensiblement constant le long des parties arrière (20) et centrale (18) de la racine.

6. Vis (12) selon la revendication 2, dans laquelle ladite racine (14) comprend en outre une partie avant (16) sur laquelle est formée une région conique, ladite région conique de la partie avant s'étendant sensiblement entièrement entre ladite extrémité avant (26) et ladite partie centrale (18) et étant plus grosse vers la partie centrale (18) que vers l'extrémité avant (26).

7. Vis (12) selon la revendication 1, dans laquelle la crête (38) du filetage présente une face supérieure (39) ayant une largeur qui augmente vers l'extrémité arrière de la racine (14).

8. Vis selon la revendication 1, dans laquelle la racine (14) est pourvue d'une canule.

9. Vis selon une quelconque des revendications 6 à 8, dans laquelle les parties avant et arrière (20) ont sensiblement la même longueur.

10. Vis (12) selon la revendication 1, dans laquelle la région conique (14) a une pente de 7 degrés environ.

11. Vis (12) selon la revendication 1, comprenant un canal qui s'étend longitudinalement à travers la racine, de l'extrémité avant à l'extrémité arrière, le canal comportant une emboîture hexagonaledans la partie arrière, pour l'accouplement d'un tournevis, et une configuration de section transversale circulaire dans les parties centrale et avant.

12. Vis (12) selon la revendication 1, incluant une partie de nez arrondie raccordée à l'extrémité avant de la racine.

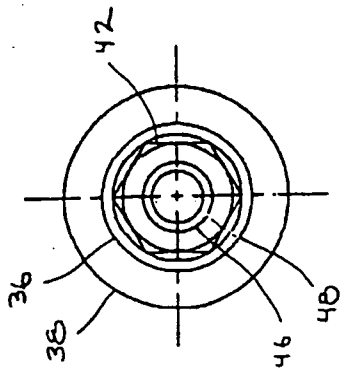
42
36
38
46
48

FIG. 2

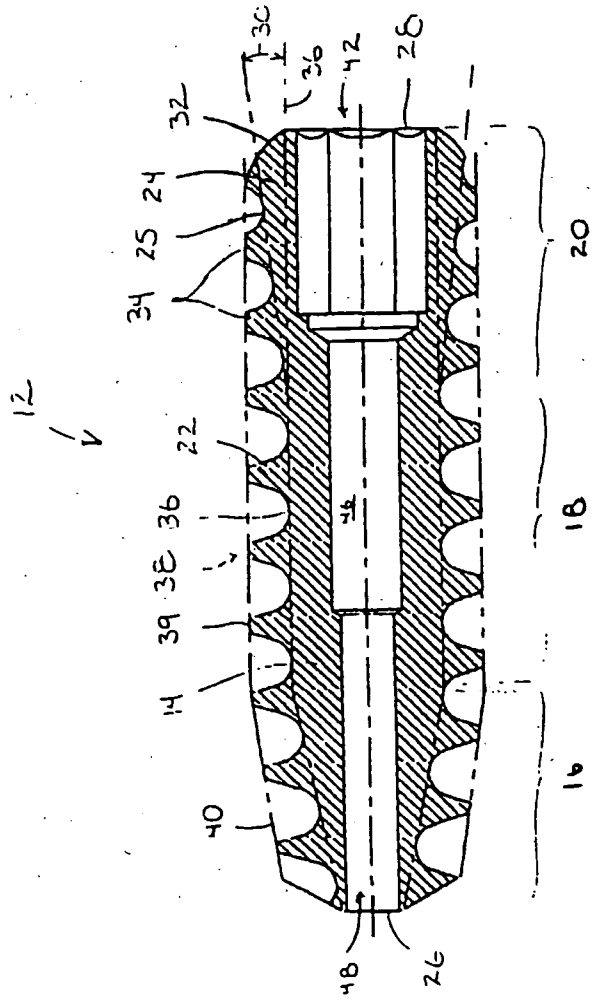
12
32
24
25
34
22
36
38
39
14
40
30
36
42
26
20
18
16
48
26

FIG. 1

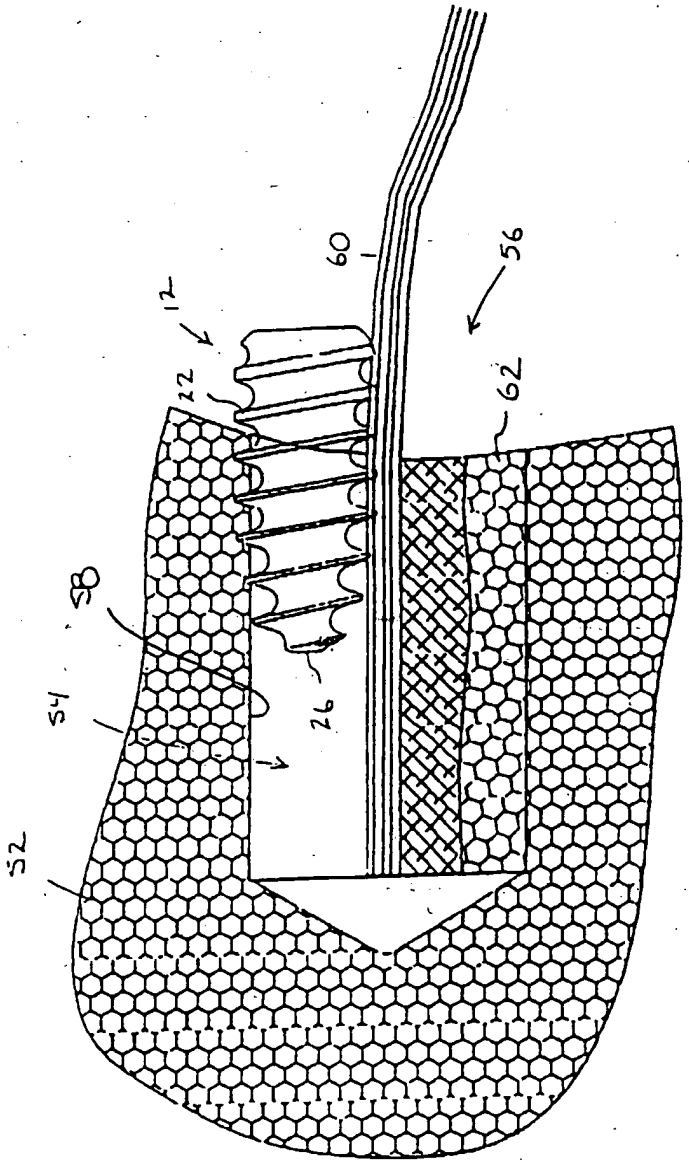

FIG. 3

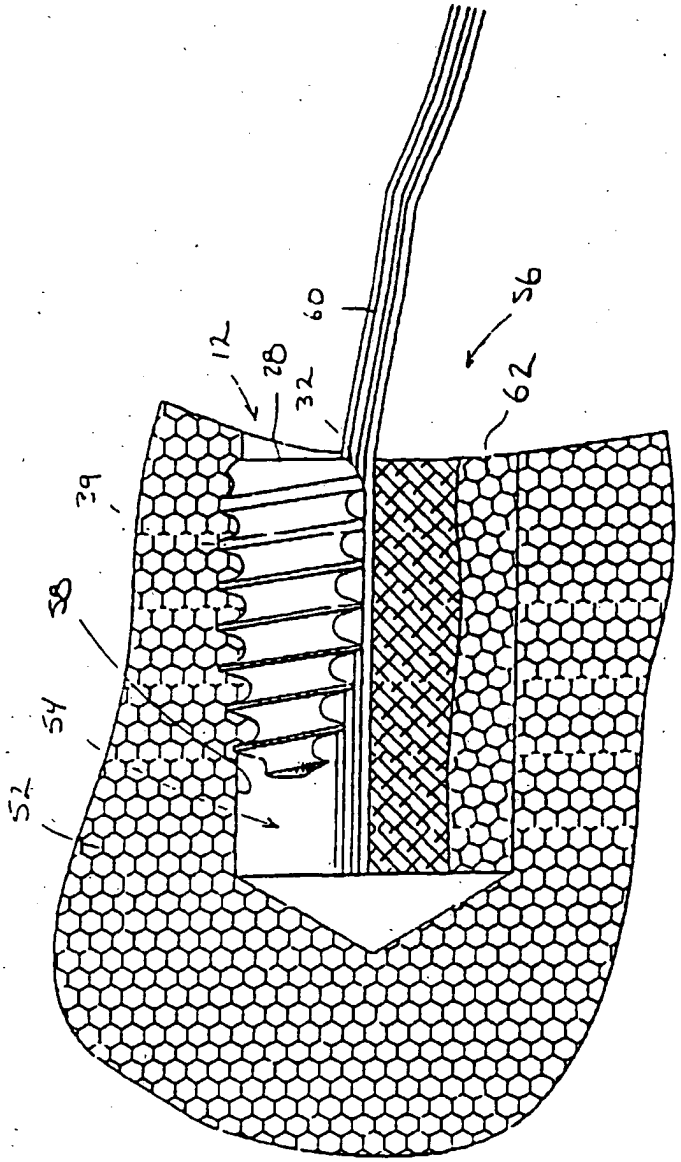

FIG. 4

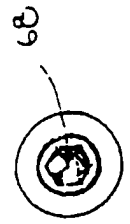

FIG. 6

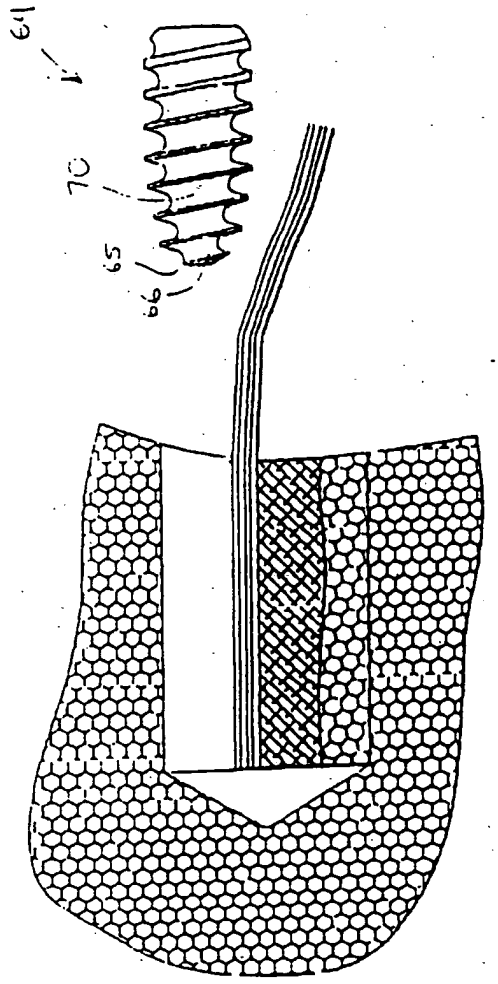

FIG. 5